IS 11282 (2000): Guidelines for Laboratory Pot-grate Sintering Tests for Iron Ore Fines [MTD 13: Ores and Raw Materials]

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भारतीय मानक

लौह अयस्क के सूक्ष्म कणों के लिए प्रयोगशाला में प्रयुक्त पॉट - ग्रेट सिंटरिंग परीक्षणों हेतु दिशा निर्देश

(पहला पुनरीक्षण)

Indian Standard

GUIDELINES FOR LABORATORY POT - GRATE SINTERING TESTS FOR IRON ORE FINES

(First Revision)

ICS 73.060.10; 01.110

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 4

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Ores and Raw Materials Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1985. While reviewing the standard in the light of experience gained during these years, the committee decided to revise it to bring it in line with the present practices being followed by the Indian Industry.

Pot-grate sinter test is a method by which input and operating parameters for sintering of given raw materials can be established. The test data are useful in design of sinter plants and optimization **of existing** plant practices for improving sinter productivity as well as quality. Several procedures exist for sintering on a pot-grate and the purpose of this guideline is to evolve a common test procedure which will facilitate comparision of results obtained by tests done at different laboratories.

In the present revision following modifications have been made:

a) Clauses **2.1**, **2.2**, **2.3**, **3.4**, **3.5**, **4.1**, **4.3**, **5.3.1** and 5.4 have been modified.

b) Fig. 1 has been modified.

c) Guidelines for chemical analysis of iron ore (dry basis) have been incorporated in Annex A.

d) Annex B for chemical analysis and size distribution of various ores used in the ore mix has been included.

e) Annex D is modified.

f) A new clause on references has been incorporated.

In the revision of the standard, assistance have been drawn from IS0 8263 : 1992 'Iron ore fines -Method for presentation of the results of sintering test'.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

GUIDELINES FOR LABORATORY POT-GRATE SINTERING TESTS FOR IRON ORE FINES

(First Revision)

1 SCOPE

This standard gives the guidelines for the method for sintering tests in the laboratory using a pot-grate unit and is applicable for sintering of iron ore fines. These guidelines have been formulated to facilitate comparison of test data from various organizations on the same sinter tnix. For individual organizations, the parameter tnay be varied. as required.

2 REFERENCES

The foliowing Indian Standards contain provisions which through reference in this text, eonstitute provision of this standard. At the time ofpublication. the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the tnost recent editions of the standards indicated below:

IS No.	*Title*
6495 : 1984	Method of tutnbler test for iron oxides :lump ores, sinter and pellets (*first* revision)
8167: 1989	Method for detertnination of reducibility index of iron ore oxides, lutnps ore, sinter and pellets (*first revision)*
10823 : 1994	Methods for determination of thermal degradation index (TDI) and reduction degradation index (RDI) of iron oxides : lump ore, sinter and pellets (*first revision)*
11283 : 1985	Detertnination ofsoftening point of iron oxides (in powder form) : lump ore, sinter and pellets
11292: 1985	Detertnination of relative reducibility of iron oxides : lump ore, sinter and pellets
12550 : 1988	Methods of determining particle size distribution of iron ore fines

3 TEST SAMPLE

3.1 The raw materials for test sample for sintering tests shall have the following size ranges:

Iron ore. iron bearing tnaterials and other materials, -10 mm or (- 8 mm if- 8 mm classifying fines are used) = 95 percent, *Min* (with a tnean size not in excess of 3 mm);

Fluxes coke breeze and other additives – 3.2 mm = 90 percent *Min* -1 mtn fraction in coke breeze : 75 percent *Max*

3.2 Sinter mix components that is iron ore fines, coke breeze, litnestone tines. dolomite tines, sinter return, and metallurgical waste shall be mixed in-dry condition in a mixer by rotating for 2 min. Water is to be added to sinter mix for 1 min duration so that the tnoisture content of sinter mix attain predetermined value. After moistening the tnixer is to be rotated for 2 min for granulation.

3.2.1 In case of double layer charging. only 70-80 percent of coke breeze shall be added during initial mixing. After balling halfofthe mix. it shall be retnoved and charged into the sinter pot. The balance of coke breeze shall be added to the sinter mix in the mixer and mixer shall be rotated further for 1 min.

4 APPARATUS

4.1 The test apparatus consists of a square pot of 400 mm x 400 mm size so that at least 50-60 kg of net sinter (+ 6.3 mm) may be produced so that it is sufficient for shatter, tumbler, reducibility, low tetnperature break down, softening tests, chemical analysis, screen analysis, etc. A typical layout is given in Fig. 1.

4.2 The bed height of sinter should generally be kept at 300 mm (excluding the hearth layer).

4.3 In case ignition is obtained by using a gas flame, the ignition intensity for gaseous fuels shall be 35 MJ/m^2, *Min* and an ignition titne of 90s shall be allowed.

4.4 During ignition of the mix, suction tnay be maintained at 300 mm WG, *Min.* After ignition either suction below grate say 800 mm is to be kept constant by tnanuplating leakage in waste gas track or tnaintaining constant air flow through the bed.

4.5 The permeability of the sinter bed shall be tnonitored throughout the experiment. Green permeability of sinter mix is to be measured before ignition at various levels of suction that is, 300, 500, 800 tntn WG.

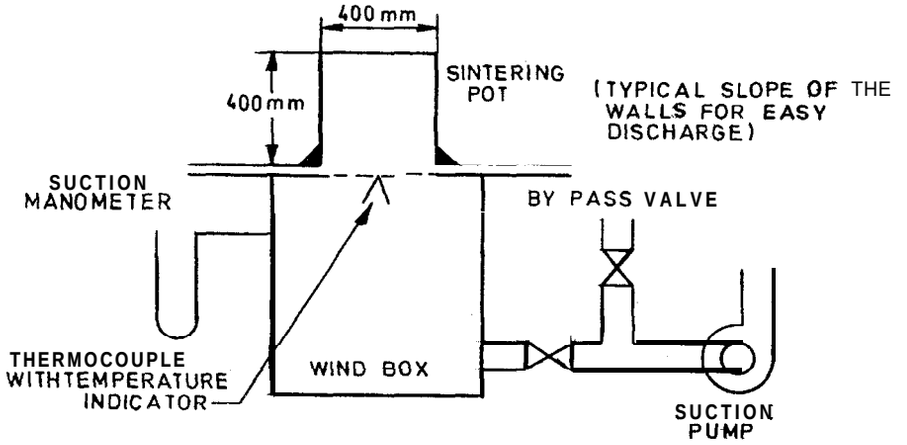

FIG. 1 SCHEMATIC ARRANGEMENT OF LABORATORY POT SINTERING UNIT

4.5.1 The permeability(P) shall be estimated by using the relation $U = P (S/H)^{0.6}$, where U is the linear air velocity in m/min at suction S in mm of WG. H is bed height in mm.

4.5.2 A typically 20 mm square screen should be placed over the pot for charging of green mix and the charge should be uniformly distributed over the screen.

4.5.3 Hearth layer height and size should be choosen depending on the bed height and commercial practice.

4.6 The bed temperature and the waste gas temperature below the grate may also be measured continuously.

4.7 In case the sintering is done under different conditions of pot size, bed height, ignition and suction conditions, the same shall be indicated along with the results.

5 PROCEDURE

5.1 This mix shall be transferred carefully in the pot containing about 25 mm thick hearth layer of S-20 mm size sinter to get the desired bed height. The ignition of the top layer of the bed. by red hot coke breeze, saw dust and a gaseous/liquid fuel flame, shall be started and desired suction achieved in 30 s.

5.2 The temperature of the waste gases shall be monitored and suction continued till 1 min after the maximum waste gas temperature is achieved.

Often during the sintering experiments. two temperature peaks are observed and hence temperature monitoring should be continued upto 5 min after the appearance of the first peak. Sintering time should be taken as the time at which the maximum temperature is recorded.

5.3 The sinter then shall be allowed to cool to room temperature in the port itself. The sinter cake shall be dislodged after cooling and weighed. The cake shall then be stabilized. Stabilization should be determined depending upon a practice so as to generate similar proportion of return fines as in the plant. The -6.3 mm fraction shall be reported as 'Return Fines' and +6.3 mm fraction shall be taken for various physical/chemical tests as per the relevant Indian Standards.

6 REPORTING OF TEST RESULTS

6.1 All additions shall be reported based on percentage of green ore mix.

6.2 A minimum of 4 tests shall be conducted under any given set of conditions. Out of these 4 tests at least in two tests, sintering times match within ±10 percent and return tines balance comes within ±5 percent. The average of these two tests should be taken as representative values for all parameters.

6.3 Sintering conditions and sinter properties shall-be reported as follow:

a) Pot dimensions;
b) Mix granulometry before mixing and after balling as per the format given in Annex A;
c) Chemical composition of feed, as per format given in Annex B;
d) Moisture content:
e) Sinter mix composition including coke breeze as per format given in Annex C;
f) Ignition condition (time of ignition. ignition intensity, etc);
g) Bed height:
h) Suction;
j) Maximum temperature reached in the bed;
k) Maximum waste gas temperature:
m) Sintering time;
n) Return fines generation;
P) Sinter composition; and
q) Screen analysis of sinter.

6.4 The sinter test data shall be reported as per the format given in Annex D. The tests for various properties indicated in Annex E shall be conducted as per the relevant Indian Standards.

ANNEX A

[*Clause* 6.3 (b)]

CHEMICAL ANALYSIS (DRY BASIS) AND SIZE DISTRIBUTIONS OF THE VARIOUS ORES INCLUDED IN THE ORE MIX

A-1 The chemical analysis (dry basis) and size distribution of the various ores included in the ore mix shall be determined as per IS12550, shall be reported as follows:

	Ore A	Ore B	Ore C	Ore D	Sinter Mix	Mill Scale and/or Other	Test Ore
Mineral Type (percent)							
Fe (total)							
FeO							
SiO_2							
Al_2O_3							
CaO							
MgO							
MnO							
S							
P							
Na_2O							
K_2O							
C							
Loss on Ignition							
Combined water							
Moisture Content							
Size Distribution (percent)							
+ 8.0 mm							
– 8.0 mm + 5.6 mm							
– 5.6 mm + 4.0 mm							
– 4.0 mm + 2.0 mm							
2.0 mm + 1.0 mm							
– 1.0 mm + 0.5 mm							
- 0.5 mm + 0.25 mm							
– 0.25 mm + 0.125 mm							
– 125 µm + 63 µm							
- 63 µm							

Method of size analysis:
Dry sieving

ANNEX B

[Clause **6.3 (c)]**

CHEMICAL ANALYSIS (DRY BASIS) AND SIZE DISTRIBUTION OF IRON ORE, FLUXES, FUEL AND RETURN SINTERED FINES

B-I The chemical analysis (dry basis) and size distribution of iron ore, fluxes. fuels and return sintered fines shall be determined as per IS 12550, shall be reported as follows:

Sl No.	Percent	Iron Ore	Coke or Other Fuel	Limestone	Dolomite	Siliceous Material	Other Fluxes	Return Sinter Fines	Steel Plant Waste Material
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Mineral Type								
1.	Fe(total)								
2.	FeO								
3.	SiO_2								
4.	Al_2O_3								
5.	CaO								
6.	MgO								
7.	MnO								
8.	S								
9.	P								
10.	$Na_2O + K_2O$								
11.	c								
12.	Ash								
13.	Volatile matter (VM)								
14.	Combined water								
15.	Loss on ignition								
	Moisture Content								
	Size Distribution								
1.	+ 8.0 mm								
2.	+ 5.6 mm								
3.	+ **4.0** mm								
4.	+ 2.0 mm								
5.	+ 1.0 mm								
6.	+ **0.5** mm								
7.	+ **0.25** mm								
8.	+ 0.125 mm								
9.	+ *0.063* mm								
10.	**-0.063** mm								
	Method of size analysis: *Dry sieving*								
	Granulometry of dry mix								
	Granulometry of green mix								

ANNEX C

[*Clause* 6.3 (e)]

COMPOSITION OF THE SINTER FEED

C-1 The composition of the sinter feed shall be reported as follows:

Sl No.	Constituents of Sinter Feed (Percent), Dry Basis	Test I	Test 2	Test 3	Test 4
(1)	(2)	(3)	(4)	(5)	(6)
1.	Ore mix				
2.	Return sintered lines				
3.	Siliceous material				
4.	Limestone				
5.	Dolomite				
6.	Other fluxes (if any)				
7.	Coke (or alternate fuel)				
8.	Other additions (if any)				

ANNEX D

(*Clause* 6.4)

SINTERING TEST DATA SHEET

D-1 The sintering test data shall be reported as follows:

Sl No.	Item	Test I	Test 2	Test 3	Test 4
(1)	(2)	(3)	(4)	(5)	(6)

a) *Sinter to be charged*

1. Mass of hearth layer, M_2 (kg)
2. Mass of sinter feed charged wet (kg)
3. Moisture content of feed (percent)
4. Percent moisture content for maximum permeability
5. Bulk density of feed wet (t/m^3)

b) *Conditions of Sinter Test*

1. Mixing time — 1st stage (min)
   -- 2nd stage (min)
2. Pot-grate area, (m^2) (A)
3. Height of hearth layer (mm)
4. Net bed height (mm)
5. Suction (mm WC)- During ignition
   — During sintering
6. Ignition time (min)
7. Cooled — In smter pot
   — Discharged hot
8. Sinter stabilization treatment
   --Tumble : No. of revolutions
   : Drum size length (mm) x dia (mm)
   — Shatter : No. of drops
   : Height dropped (mm)

9. Sieving aperture size for separating return sintered fines (mm)
10. Ignition intensity (mcal/m^2/mm)
11. Ignition temperature (^{O}C)

c) *Sintering Test Results*

1. Mass of sinter cake. M_3 (kg)
2. Mass of return sintered fines produced (kg)
3. Mass of sinter produced of acceptable size, M_1 (kg)
4. Sintering time, t(h)

5. Productivity ($t/m^2/h$) $= \dfrac{(M_1 - M_2)/1\,000}{\text{Pot area in } m^2 \times \text{Sintering time in h.}}$

6. Coke consumption :– kg/t sinter
   kg/t contained Fe in sinter

7. Return sintered fines (percent)

$$= \frac{(M_3 - M_1)}{(M_3 - M_2)} \times 100$$

$$\text{Percent Yield} = \frac{M_1 - M_2}{M_3 - M_2} \times 100$$

8. Sinter return balance $= \dfrac{\text{Sinter return generated}}{\text{Sinter return output}}$

ANNEX E

(*Clause* 6.4)

SINTER QUALITY DATA

E-1 The sinter quality data shall be reported as follows:

Sl No.	Item	Test 1	Test 2	Test 3	Test 4
(1)	(2)	(3)	(4)	(5)	(6)
1.	Tumble strength +6.3 mm (*As per* IS 6495)				
2.	Reduction degradation (*As per* IS 10823)				
3.	Reducibility (*As per* IS 8167)				
4.	Relative reducibility (*As per* IS 11292)				
5.	Softening tests (*As per* IS 11283)				
6.	*Chemical analysis of Sinter Product, percent*				
	Fe (total)				
	FeO				
	SiO_2				
	Al_2O_3				
	CaO				
	MgO				
	MnO				
	S				
	P				
	$Na_2 + K_2O$				
	Loss on ignition				
7.	*Basicity*: CaO/SiO_2 or $\frac{CaO + MgO}{SiO_2 + Al_2O_3}$				
8.	*Sieve Analysis, percent*				
	+40 mm				
	+25 mm				
	+15 mm				
	+10 mm				
	+5 mm				
	± 5mm				
9.	Sinter return consumption (kg/t ofsinter)				

Bureau of Indian Standards

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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Amendments Issued Since Publication

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 1 10 002
Telephones: 323 01 31, 323 33 75, 323 94 02

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :		Telephone
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Eastern :	1/14 C. I. T. Scheme VII M, V. I. P. Road, Kankurgachi CALCUTTA 700 054	337 84 99,337 85 61 337 86 26,337 9 1 20
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